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Creating opportunities: Heuristic reasoning in proactive dynamic capability deployment

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CREATING OPPORTUNITIES: HEURISTIC REASONING IN PROACTIVE DYNAMIC CAPABILITY DEPLOYMENT

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ABSTRACT

Research on dynamic capabilities (DCs) has focused primarily on reactive DC deployment (i.e., opportunity discovery) with less attention being paid to proactive DC deployment (i.e., opportunity creation). Drawing on the opportunity creation perspective in entrepreneurship, we argue that proactive DC deployment is characterized by uncertainty, which makes deductive reasoning less effective and thus requires the use of heuristic reasoning. We also incorporate the evolutionary logic of variation, selection, and retention to theorize about the role of heuristic reasoning in the process of proactive DC deployment. Specifically, we integrate the concept of ecologically rational heuristic reasoning to answer two key questions: First, how does ecologically rational heuristic reasoning facilitate proactive DC deployment when the decision context is uncertain? Second, why is ecologically rational heuristic reasoning effective for proactive DC deployment? In summary, our paper advances the ongoing debate concerning DCs and the way in which heuristic reasoning assists a firm in deploying such capabilities.

> "A creator who isn't grabbed around the throat by a set of impossibilities is no creator. A creator is someone who creates their own impossibilities, and thereby creates possibilities . . . it's by banging your head on the wall that you find a way through. You have to work on the wall, because without a set of impossibilities, you won't have the line of flight, the exit that is creation…" (Deleuze, 1995: 133).

Dynamic capabilities (DCs) underlie a firm's capacity to both react to a changing business environment by discovering new opportunities, and to proactively change the environment by creating new opportunities (Helfat et al., 2007; Teece, Pisano, & Shuen, 1997; Zahra, Sapienza, & Davidsson, 2006; Zott, 2003). Given the importance of DCs to a firm's competitive advantage (Girod & Whittington, 2017; Schilke, 2014; Teece, 2007), scholars have devoted much attention to improving our understanding of DCs and their related antecedents and outcomes. For instance, we have learned that DCs affect firm performance by modifying the firm's resources and capabilities to take advantage of opportunities (see Barreto, 2010; Helfat et al., 2007; Peteraf, Di Stefano, & Verona, 2013; Vogel & Güttel, 2013) and enable resource reallocation within organizations (Lovallo, Brown, Teece, & Bardolet, 2020). Despite extensive research on DCs, however, several aspects of DC deployment and its underlying process remain unclear (see Peteraf et al., 2013; Schilke, Hu, & Helfat, 2018). For example, in terms of decision making underlying DC deployment, some scholars have suggested the importance of emotions (Hodgkinson & Healey, 2011) and heuristic reasoning (i.e., simple decision rules [Eisenhardt & Martin, 2000]), whereas others have emphasized the primacy of deductive reasoning (Teece, 2007).

In this paper, we address the limitations of current theorizing by first arguing that the existing literature has predominantly applied a reactive rather than a proactive view of DC deployment (e.g., Benner & Tushman, 2002; Eisenhardt & Martin, 2000; Harreld, O'Reilly III, & Tushman, 2007; Teece, 2007; Teece et al., 1997). The former is about responding to exogenous

changes in the environment (i.e., the discovery perspective) (Day, 2011; Pitelis & Teece, 2010), while the latter is about creating changes endogenous to the firm (i.e., the creation perspective) (Alvarez & Barney, 2007). Although firms engage in both reactive and proactive DC deployment, they involve different decision-making contexts—risk vs. uncertainty—that in turn requires different decision-making approaches—deductive vs. heuristic reasoning (Alvarez & Barney, 2007).

Given the wealth of existing knowledge on reactive DC deployment, we focus specifically on the less understood, but very relevant, proactive DC deployment to develop a theory explaining its underlying process. To do so, we incorporate the concept of opportunity creation from the entrepreneurship literature (Alvarez & Barney, 2007; Alvarez, Barney, & Anderson, 2013; Arikan, Arikan, & Koparan, 2020). Alvarez and Barney (2007) clarified the distinction between opportunity creation and discovery as well as their associated decision-making contexts. They argued that opportunity discovery is associated with "risk" because the availability of information enables the estimation of possible outcomes. Thus, deductive reasoning is an appropriate decision-making approach in this context. In contrast, opportunity creation is associated with "uncertainty," which is characterized by a lack of sufficient information, thereby preventing the estimation of possible outcomes (Alvarez & Barney, 2005, 2007). Accordingly, the use of heuristic reasoning is appropriate in this context. Building on this latter argument, we draw on the ecologically rational heuristic perspective to explain the role of heuristic reasoning in proactive DC deployment. The ecologically rational heuristic perspective emphasizes the need for functional matches between cognition and the environment (i.e., ecologically rational), especially when a high degree of uncertainty is present (Gigerenzer & Gaissmaier, 2011; Mousavi & Gigerenzer, 2014).

Our paper clarifies two aspects of heuristic reasoning in proactive DC deployment. First, we incorporate the evolutionary logic of variation, selection, and retention (Aldrich & Ruef, 2006) from the opportunity creation perspective (Alvarez & Barney, 2007) to explain the underlying process of proactive DC deployment. Specifically, we explain *how* heuristic reasoning facilitates the sensemaking and development of new ideas during the variation stage, the identification of potentially promising ideas for new opportunities during the selection stage, and the retention of effective heuristics that underpin proactive DC deployment during the retention stage. Second, we draw on the "bias-variance tradeoff"[1]—a central element of ecologically rational heuristic reasoning (Artinger, Petersen, Gigerenzer, & Weibler, 2015)—and the iterative learning process to clarify *why* heuristic reasoning in proactive DC deployment leads to a better perceived alignment between a new opportunity to its potential market. In doing so, we explain how iterative learning during proactive DC deployment promotes the balance between bias and variance (i.e., the main error components) in decision making and hence increases the confidence (i.e., belief in the expected outcome) in heuristic reasoning over time. This process of proactive DC deployment in turn leads to creating a new opportunity (e.g., a new product or service).

Our theorizing makes four primary contributions. First, we respond to Schilke, Hu, and Helfat's (2018) call to infuse the DC view with psychological theory on heuristic reasoning and to incorporate insights from entrepreneurship literature. More specifically, we extend the DC

[1] We agree with Alvarez and colleagues' perspective that opportunity creation "should sidestep positivism" as the positivist language "comes from framing opportunities as objective, discoverable objection" (Alvarez, Barney, McBride, & Wuebker, 2014: 230, 227). However, for our key arguments to be clearly understood by a wider audience in the cognition and decision-making literature, we sometimes adopt positivist terms, such as "error," "bias," and "variance."

literature by explaining how the distinction between opportunity discovery and opportunity creation clarifies our understanding of the uncertain nature of proactive DCs and how heuristic reasoning facilitates its deployment. Second, we improve our understanding of the process underlying proactive DC deployment, in particular the role of heuristic reasoning, which remains limited in the literature. The current literature has focused primarily on heuristic reasoning in the reactive discovery of opportunities (e.g., Eisenhardt & Martin, 2000; Peteraf et al., 2013), thereby raising questions about the applicability of these arguments to proactive DC deployment. Our theorizing therefore clarifies the underlying mechanisms of heuristic reasoning and its enabling characteristics for proactive DC deployment. Third, by shedding light on how and why heuristic reasoning facilitates the proactive creation of opportunities, we also contribute to the strategy and the entrepreneurship literatures where the use of heuristic reasoning in opportunity creation is suggested, but its enabling mechanism is not fully explained (e.g., Alvarez et al., 2013; Foss & Klein, 2017; Maine, Soh, & Dos Santos, 2015). Fourth, our theorizing on the underlying mechanism of proactive DC deployment contributes to the resource-based view of the firm, particularly a more nuanced understanding of sustainable competitive advantage. Specifically, we clarify where heterogeneous resources and capabilities come from and how they shape the foundation of firms' sustainable competitive advantage (Alvarez & Barney, 2007; Barney, Wright, & Ketchen, 2001).

THEORETICAL BACKGROUND

Dynamic Capabilities

DCs are "the capacity of an organization to purposefully create, extend or modify its resource base" (Helfat et al., 2007: 1). This ability rests on the firm's reaction to opportunities ahead of competitors (i.e., reactive DC deployment) (Adner & Helfat, 2003; Teece et al., 1997),

proactive creation of new opportunities (i.e., proactive DC deployment), or both (Teece, 2007). Given the value of DCs, a large body of research has investigated their underlying processes and associated outcomes (see Barreto, 2010; Lampert, Kim, & Polidoro Jr, 2020; Peteraf et al., 2013; Vogel & Güttel, 2013). For example, these studies have discussed the positive effects of DC deployment through mergers and acquisitions (Meyer-Doyle, Lee, & Helfat, 2019), organizational reorganization (Girod & Whittington, 2017), and resource reallocation (Lovallo et al., 2020). Others have investigated DC deployment by explaining its antecedents and development process, with a specific focus on its cognitive and psychological foundations (e.g., Eisenhardt & Martin, 2000; Felin, Foss, Heimeriks, & Madsen, 2012; Helfat & Peteraf, 2015; Hodgkinson & Healey, 2011; Kaplan, 2008; Tasheva & Nielsen, 2020; Teece, Peteraf, & Leih, 2016; Teece, 2007; Zollo & Winter, 2002; Zott, 2003). For example, Helfat and Peteraf (2015) drew on the attention-based view (Ocasio, 1997) to explain the role of perception and attention in sensing opportunities in DC deployment.

Eisenhardt and Martin (2000) suggested that when information is limited and the estimation of decision outcomes is not possible, DC deployment demands the use of heuristic reasoning. In the same vein, Helfat and Peteraf (2015) suggested that heuristic reasoning can be effective in DC deployment, particularly when managers face time pressure to make decisions or when problems are ill-defined. Teece (2007), in contrast, argued that deductive reasoning (e.g., scenario planning) is the preferred route since heuristic reasoning is prone to bias and may lead to inferior DC deployment. Zollo and Winter (2002) also emphasized the role of deductive reasoning (e.g., through the use of knowledge articulation and codification) and suggested that such reasoning is effective in DC deployment (Barreto, 2010).

While this body of research has added significantly to our understanding of DCs, we argue that the conflicting views on the value of heuristic reasoning are rooted in a lack of distinction between reactive and proactive DC deployment. That is, while DC deployment can be reactive, proactive, or both, most DC research discusses DC deployment in the context of exogenous change, which focuses particularly on a *reactive* view. However, DC deployment can also be *proactive*, which has received less attention in the literature (Pitelis & Teece, 2010). This narrow focus has resulted in a lack of understanding of proactive DC deployment's underlying mechanisms and implications. Below, we develop our framework for the proactive DC deployment process. First, we draw from entrepreneurship research to contrast opportunity discovery, which is associated with risk, with opportunity creation, which is characterized by uncertainty. We then focus on discussing the role of heuristic reasoning in proactive DC deployment associated with uncertainty.

Opportunity Discovery vs. Opportunity Creation

The entrepreneurship literature has suggested that both the discovery and creation perspectives can explain how entrepreneurs' actions lead to new opportunities (Alvarez & Barney, 2007; Berglund, Bousfiha, & Mansoori, 2020; Foss & Klein, 2017; Shane & Venkataraman, 2000). Opportunity discovery and creation, however, differ in several aspects, including the nature of the opportunity and the decision-making context, which together call for different types of reasoning (Alvarez & Barney, 2007; Alvarez & Parker, 2009; McBride & Wuebker, 2020).

The opportunity discovery perspective (Shane, 2003; Shane & Venkataraman, 2000) suggests that competitive imperfections arise exogenously through, for example, technological, demand, or regulatory changes. In such circumstances, a systematic search of the environment

can lead to a (reactive) discovery of opportunities that exist but are waiting to be discovered (Alvarez & Barney, 2005). Aligning with Knight (1921), the decision-making context of opportunity discovery is associated with risk: While the specific outcome of a given situation is unknown, there is sufficient information about the probability distribution to estimate possible outcomes. Thus, the opportunity discovery perspective suggests that firms employ deductive reasoning to estimate their odds of success. In such contexts, management can use risk assessment tools to collect and analyze relevant information to develop a better understanding of the nature of the opportunity, compared to other opportunities, and possible outcomes (Alvarez & Barney, 2007).

In contrast, the opportunity creation perspective (Alvarez & Barney, 2004) posits that opportunities do not readily exist in the market. That is, firms need to proactively create new opportunities endogenously through an evolutionary enactment process (Alvarez & Barney, 2007). In such circumstances, *ex ante* knowledge about the links between a potential opportunity and previously existing markets is unknown or does not necessarily exist. Therefore, the decision-making context within which opportunities are created is not risky, but uncertain (Alvarez & Barney, 2007). According to Knight (1921), uncertainty involves a situation in which sufficient prior information is not available, and hence both the odds of a specific outcome and the probability distribution of possible outcomes are unknown.[2] In such contexts, traditional

[2] We acknowledge that various definitions and perspectives of uncertainty exist. In this paper, we adopt Knight's (1921) concept of uncertainty and theorize based on this definition. In addition, we acknowledge that, in principle, complexity—when firms perceive a great multiplicity and diversity of factors as relevant (Miller & Friesen, 1983)—and uncertainty, despite being related, have different characteristics and thus require different decision-making approaches. However, we argue that individuals do not clearly differentiate between complexity and uncertainty and thus tend to perceive complex and uncertain situations similarly.

approaches of deductive reasoning may not be feasible due to a lack of information, while alternative approaches, such as ecologically rational heuristic reasoning, may be more effective (Mousavi & Gigerenzer, 2014).

Heuristic Reasoning under Uncertainty

Managers' use of heuristic reasoning[3] has been studied widely in the management literature, yet its benefits, particularly in uncertain decision-making contexts, remain underexplored (e.g., Amit & Schoemaker, 1993; Dew, 2007). This lack of attention has its roots in associating heuristic reasoning with cognitive biases, which implies inferiority to deductive reasoning (e.g., Busenitz & Barney, 1997; Hodgkinson, Bown, Maule, Glaister, & Pearman, 1999; Schwenk, 1984; Schwenk, 1985). This understanding of heuristic reasoning draws on the "heuristic and bias" paradigm (Tversky & Kahneman, 1974), which adopts an economic optimization view, arguing that lack of information and time as well as cognitive constraints lead managers to engage in heuristic reasoning (Kahneman, 2003). These studies, however, do not account for how uncertainty in the decision-making context may constrain "optimized" decision making because managers either disregard the underlying conditions (Bateman & Zeithaml, 1989a, b) or misconstrue them as risks (Barnes, 1984).

Building on Simon's (1955; 1976) concept of bounded rationality, the ecological rationality of heuristic reasoning challenges the traditional perspective of heuristic reasoning, which often associates its use with inferior outcomes (as a result of cognitive biases). In contrast,

[3] The entrepreneurship literature references the use of both heuristic and abductive reasoning, particularly when limited information is available to explain observations (Peirce, 1932). While we acknowledge the usefulness of abduction for generating a new idea in innovation and design contexts (Dunne & Dougherty, 2016; Dew, 2007; Powell, 2001), our theorizing focuses on heuristic reasoning.

the ecologically rational perspective suggests that in uncertain environments with poor probability estimations or limited information about alternatives, individuals and firms rely on simple heuristic reasoning in an adaptive way (Gigerenzer & Selten, 2002; Mousavi & Gigerenzer, 2014). Accordingly, two key characteristics of ecologically rational heuristic reasoning that assist firms when making decisions in uncertain environments are simplicity and adaptability.

The *simplicity* of ecologically rational heuristic reasoning lies in its focus on fewer pieces of information, allowing decision makers to solve problems and make judgments with less analytical effort (so-called "less is more"). In doing so, it "limit[s] a search of objects or information using easily computable stopping rules and [allows management to] make their choices with easily computable decision rules" (Todd & Gigerenzer, 2000: 731).

The *adaptability* of ecologically rational heuristic reasoning directs decision makers to be selective in their search for and attention to information and to only focus on information that is seemingly most relevant for a particular context (Gigerenzer & Brighton, 2009). The degree of adaptability of heuristic reasoning to align with a particular context plays a critical role in determining the confidence in its outcome (Artinger et al., 2015; Gigerenzer, 2002).[4] We define confidence as the expectation that decision makers place in the outcome of a decision (Munn, Porritt, Lockwood, Aromataris, & Pearson, 2014).

In this way, the concepts of simplicity and adaptability emphasize the importance of selective attention distribution (Ocasio, 1997). The significant role of organizational context in

[4] The ecologically rational literature commonly uses the term "accuracy" when discussing the outcome of heuristic reasoning. We, however, choose to use "confidence" to avoid positivistic language (please also see footnote 1).

selective attention (Gavetti, 2005) is a key foundation of the attention-based view, which is consistent with the ecologically rational heuristic perspective's emphasis on understanding the context in which a decision is made.

In summary, while research on DC deployment has made great strides, arguments about its underlying processes remain limited, which in part is driven by an unclear distinction between reactive and proactive DC deployment as well as a limited exploration of heuristic reasoning. While the former represents a risky environment where the use of deductive reasoning is likely to be more appropriate, the latter represents an uncertain environment where the use of heuristic reasoning is likely to be more effective (Alvarez & Barney, 2007; Alvarez & Parker, 2009). In the next section, we address these limitations by theorizing how the simplicity and adaptability of ecologically rational heuristic reasoning facilitate proactive DC deployment in uncertain contexts.

HEURISTIC REASONING IN PROACTIVE DYNAMIC CAPABILITY DEPLOYMENT

We propose a conceptual framework that (1) explicates *how* ecologically rational heuristic reasoning facilitates proactive DC deployment when the decision context is uncertain and (2) clarifies *why* ecologically rational heuristic reasoning is effective for proactive DC deployment. In doing so, we draw on evolutionary theory (Aldrich & Ruef, 2006) to delineate the core processes embedded in opportunity creation, including variation, selection, and retention (Alvarez & Barney, 2007). We refer to the initial belief about an opportunity as an "idea" before it is made sense of and developed into a business opportunity. According to the creation perspective, opportunities can only be understood retrospectively through an iterative process of action and reaction (Alvarez & Barney, 2007; McBride & Wuebker, 2020).

Figure 1 illustrates our framework and describes the two key questions we seek to answer. Specifically, we explain *how* the simplicity and adaptability of ecologically rational heuristic reasoning facilitate (1) the sensemaking and development of a new idea during the variation stage and (2) the selection of one of the variants of the new idea as well as the criteria for such decision making during the selection stage. We argue that the iterative process of variation and selection of a new idea continues until a new opportunity is created or failure occurs. We then discuss (3) the retention of heuristic reasoning, which occurs after an opportunity has been created. Finally, we draw on the concept of the bias-variance tradeoff to explain *why* the simplicity and adaptability of ecologically rational heuristic reasoning are effective for proactive DC deployment. More specifically, we argue that these two characteristics enable firms to learn from feedback during the iterative process of variation and selection and further refine their confidence in heuristic reasoning (Alvarez et al., 2013) (represented by the feedback loop in Figure 1).

Insert Figure 1 about here

How Ecologically Rational Heuristic Reasoning Facilitates Proactive DC Deployment

Variation in proactive DC deployment. Proactive DC deployment starts with *variation* (Aldrich & Ruef, 2006), which involves the making sense of and development of a new idea. While making sense of an idea involves how firms give meaning to and explain a new idea, idea development relates to how firms bring the new idea into existence. Both steps in the variation process are iterative and evolve over time as firms become clearer in their understanding of an idea and its potential value for a potential market. In the following sections, we discuss the role of heuristic reasoning in the variation process by breaking it down into two steps: making sense of an idea and idea development.

Heuristic reasoning in variation: making sense of an idea. Before a new idea can be made sense of using heuristic reasoning, it needs to be created either intentionally or blindly. Intentional idea creation occurs when individuals engage in activities to find a solution for a known problem (Amabile, 1983; Vogel, 2017). Blind idea creation occurs when individuals come up with a new idea without conscious planning or a pre-defined problem to be solved, such as in casual conversations (Aldrich & Ruef, 2006; Campbell, 1994). Regardless of how a new idea is created, it is often a vague and incomplete mental representation of a potential opportunity for a firm (Vogel, 2017). Therefore, firms need to make sense of a new idea in such a way that its unique characteristics and potential value can be understood. However, making sense of a new idea is challenging because the lack of information creates uncertainty about its potential value, its similarity to or deviation from current products or services, and how the firm should address it. Therefore, the important question here is, "How is a new idea made sense of?"

The *simplicity* of heuristic reasoning directs firms to focus on a few pieces of past information to make sense of the newly created idea. Doing so enables firms to engage in non-excessive analytical effort. The *adaptability* of heuristic reasoning directs firms in selecting those pieces of past information that are seemingly most relevant for making sense of a new idea. In other words, firms selectively attend to past information that, from their perspective, shares commonalities with the new idea and its potential value, given that under uncertainty they do not know exactly which information is relevant. That is, firms can only guess based on the available information.

Together, the simplicity and adaptability of heuristic reasoning guides firms to focus on limited, but seemingly the most relevant, past information in order to reasonably make sense (i.e., good enough) of a new idea and to assess its novelty (Todd & Gigerenzer, 2000). They

allow firms to "depart from the web of significance," "break casual structures of associates," and break away from the past and "the iron cage of the history" that try to align the understanding of a new idea to existing ones (see Garud & Karnøe, 2001: 14). However, such heuristic reasoning does not necessarily result in a complete understanding of a new idea in proactive DC deployment. Rather, it assists firms in developing a reasonable understanding of the new idea, its distinctiveness, and its potential value using less information and less analytical effort (see Figure 1). By doing so, heuristic reasoning helps generate momentum around the new idea (Garud & Karnøe, 2001) as well as the initial legitimacy and acceptance needed for putting it into further action (Hargadon & Douglas, 2001).

An example of such heuristic reasoning is the one-reason heuristic (Todd & Gigerenzer, 2000), which guides a decision maker to rely on one specific criterion to make sense of a new idea and its relationship to existing products or services (Todd & Gigerenzer, 2000). By relying on one specific criterion, the one-reason heuristic is simple and requires less analytical effort. It is also adaptable because this one specific criterion is selected from past information that is perceived as most relevant in relation to the new context.

For instance, in developing Post-it Notes, the 3M scientist, Spencer Silver, asked, "Aren't there times when you want a glue to hold something for a while but not forever?" (Nayak & Ketteringham, 1986: 43-44). In his effort to make sense of the potential of low-tack adhesive, Silver relied on a single criterion: the adhesive characteristic of his weak glue—a commonality shared with normal glue. This illustrates the adaptability of Silver's heuristic reasoning, as this criterion was perceived as most relevant for his making sense of a new product, Post-It Notes. By engaging in a simple reasoning process and ignoring other characteristics of normal glue (e.g., the ability to hold two objects tightly and permanently together), he identified possible

differences and novelties of the weak glue. Thus, such reliance on a single criterion from the set of past information assisted him in reasonably making sense of a new idea—weak glue—and its potential value for 3M.

Heuristic reasoning in variation: idea development. Once an idea has been reasonably made sense of, the next step is to develop it. At this stage, the critical question is, "What are the possible paths for developing the new idea?" Given the inherent uncertainty in proactive DC deployment, it is difficult for firms to rely solely on existing knowledge, capabilities, and resources to identify a clear path for idea development. Hence, in such contexts, new knowledge and resource configurations are necessary. Yet, in the case of proactive DC deployment, no clear understanding exists about the specific new knowledge and resources required, as well as where or how they can be obtained. This, however, does not suggest that firms are fully unaware or unable to collect any information about how to further develop a new idea (Alvarez & Barney, 2007).

The *simplicity* of ecologically rational heuristic reasoning suggests that firms rely on a few pieces of know-how from existing actions and implementation processes to start taking actions toward developing a new idea. We define know-how as practical knowledge on how to accomplish a task (e.g., knowledge about the design and development of a product or service). The focus on only a few pieces of know-how, therefore, enables firms to sufficiently understand how to start acting on a new idea while engaging in less analytical effort. The *adaptability* of heuristic reasoning guides firms to identify those pieces of the existing know-how that are assumed to be most relevant for starting the development of a new idea.

In addition, the adaptability of heuristic reasoning allows for deviation from existing know-how and learning through experimentation (Berglund et al., 2020; Garud & Karnøe, 2001),

which leads to new know-how. It also facilitates new idea development by integrating both new and existing know-how (Eisenhardt & Martin, 2000; Lavie, 2006; Teece, 2007). Together, the simple and adaptive nature of heuristic reasoning enables firms to compensate for the uncertainty inherent in proactive DC deployment by focusing on a few pieces of existing know-how that are seemingly most relevant to the new context. Reliance on such know-how enables firms to develop a sufficient understanding of how to take an initial action to develop a new idea.

We can see the process of reliance on a few pieces of relevant existing know-how for developing a new idea by returning to our Post-It Notes example. Dr. Silver and his colleague at 3M, Arthur Fry, began the new idea development process by thinking of existing parts they could use to assemble the new manufacturing equipment, as well as the people who could help. Fry explained, "At 3M, we've got so many experts and so much equipment scattered around that we can […] make the adhesive and some of the raw materials here, and do one part over here, and another part over there, and convert a space there and make a few things that aren't available" (Nayak & Ketteringham, 1986: 50).

This example illustrates how Fry and his team searched for existing know-how within 3M and took the initial actions after finding a few pieces of relevant know-how. This process reflects the simplicity of heuristic reasoning, as it requires less analytical effort. In addition, it demonstrates the adaptability of heuristic reasoning, as the process initially relied on the seemingly most relevant know-how from within 3M and then was continuously refined as they progressed through an iterative process of action and reaction. It took the company two years to explore existing know-how, engage in iterative learning through a series of trial and error, and invent variants of new machines and production. 3M eventually discarded most of them before successfully developing the manufacturing machine and process for Post-it Notes.

In sum, the variation stage in Figure 1 describes *how* heuristic reasoning facilitates (1) making sense of a new idea by directing a firm's attention to identify a few pieces of past information that are perceived as most relevant for providing reasonable meaning to the newly created idea, and (2) the development of a new idea by assisting a firm in identifying a few pieces of existing know-how that are perceived as most relevant to sufficiently understand how to act.

Selection in proactive DC deployment. Following the variation stage is the *selection* stage, which involves the decision to abandon or pursue a new idea (Aldrich & Ruef, 2006). Given the uncertainty surrounding a new idea, firms often come up with multiple variants during proactive DC deployment. However, given the scarcity of firms' resources, firms need to decide which variant should be selected for further development and which should be abandoned (Aldrich & Ruef, 2006).

Heuristic reasoning in selection. Since proactive DC deployment concerns a new idea that may not be comparable with existing perceptions or practices (Nayak & Ketteringham, 1986), firms usually lack the relevant information to ask, "Which variant of a new idea should be selected for further development?" The answer is unclear because the process of proactive DC deployment involves uncertainty around the key criteria that affect the acceptance of a new idea. This suggests that firms must deviate from the criteria associated with existing markets to develop an understanding of criteria that are more relevant to the new market. Such a decision, however, is challenging because deviation from the existing market can be threatening to the firms' current products or services. Thus, the key challenge in such uncertain contexts is to understand the extent to which the deviation and its effects are acceptable to the current business, while being sufficiently worthwhile to pursue new opportunity creation (Garud & Karnøe, 2001).

The simplicity and adaptability of heuristic reasoning enable firms to generate a limited set of selection criteria that are perceived to be aligned with the new context and use them to evaluate and choose a variant of a new idea that is perceived as being worth developing. Specifically, the *simplicity* of heuristic reasoning suggests that firms focus on a few key selection criteria, allowing them to exert less analytical effort by processing just-enough information to assess and pursue a selected variant of a new idea while reducing the chances of failure. The *adaptability* of heuristic reasoning directs firms toward identifying those criteria drawn from their experience with existing products or services that are perceived to best suit the new market for pursuing a variant of a new idea. Hence, simple and adaptive heuristic reasoning enables managers to select one variant of a new idea that is perceived to align with their understanding of the potential new market, while simultaneously leaving room for divergence from the existing market as they move forward and engage in the iterative process of action and reaction.

An example of heuristic reasoning at the selection stage is the tallying heuristic, which counts the number of criteria favoring one variant over another (Gigerenzer & Goldstein, 1996). The use of the tallying heuristic can be seen in JVC's development of the videocassette recorder (VCR). Yuma Shiraishi and his team generated a set of criteria (e.g., price, easy to use), adapted from two existing criteria: Could it be used at home? Is it affordable to the average consumer? The team used this limited number of criteria to decide whether a variant of the VCR should be selected for further development. A variant would be selected only if its number of positive attributes exceeded its negative attributes (Artinger et al., 2015; Nayak & Ketteringham, 1986). The tallying heuristic illustrates both the simplicity and adaptability of heuristic reasoning. It is simple because the team focused on a limited number of criteria. It is adaptable because these

criteria were reconstructed from the initial criteria based on the team's experience to align with the VCR market.

In sum, the simplicity and adaptability of heuristic reasoning facilitate selecting what firms perceive as the most promising variant of a new idea (see the selection stage in Figure 1). In doing so, such reasoning directs firms to focus on only a few and seemingly most relevant criteria to pursue a variant of a new idea that is perceived to best suit the potential new market.

As also illustrated in Figure 1 (see the iterative learning process between and within the variation and selection stages), firms repeatedly go through the variation and selection stages of proactive DC deployment to refine their sensemaking of existing ideas and create new ones, explore different paths for idea development, and refine selection criteria based on feedback and experience. This iterative process continues until a variant of an idea emerges to successfully become a new opportunity or the process is terminated (Alvarez et al., 2013).

Retention in proactive DC deployment. As firms complete the variation and selection of proactive DC deployment and create a new opportunity that is well received by the market, it is important that they retain the heuristics underlying the opportunity creation process. The retention process is particularly crucial in uncertain environments, as it enables firms to economize on information processing and reduce their analytical effort. More specifically, it enables a firm to routinize certain activities, while paying more attention to the ongoing changes in the uncertain environment (Aldrich & Ruef, 2006).

Retention of heuristic reasoning. Through the iterative process of variation and selection, firms accumulate a set of heuristics that facilitates the replication of a newly created opportunity. Thus, the important question here is, "How can the firm retain useful heuristics?" that facilitate future replication and a better sense of variants of the newly created opportunity.

The retention of useful heuristics, however, is challenging. The inherent uncertainty of proactive DC deployment necessitates continuous updates and additions to heuristics throughout the variation and selection stages (see the feedback loops within variation and selection, and the feedback loop between the variation and selection stages in Figure 1). A result of this iterative process is therefore a refined set of heuristics that have become more specific to a particular set of inferences based on experiences firms gain through this iterative process. This process inherently allows the heuristics to become more sophisticated (less simple) and to align more closely with the specific contexts in which they have been developed. While such highly specific heuristics enable firms to increasingly rely upon them, their lack of simplicity can make their memorability challenging (Ellis & Shpielberg, 2003). In addition, such highly specific heuristics are less adaptable to the changing business environment, making them less useful for making sense of variants of the newly created opportunity (see the feedback loop between retention and variation stage in Figure 1).

To ensure that the simplicity and adaptability of heuristics are maintained, firms undergo a process of *simplification cycling* (Bingham & Eisenhardt, 2011), which involves the pruning of heuristics (see the retention stage of Figure 1). Such simplification, however, must be conducted with caution, as simply pruning to reduce the number of heuristics or criteria without careful thought may result in underexploiting past experiences. Instead, as firms gain more experience through the iterative process of proactive DC deployment, they engage in simplification cycling by adding, removing, and/or refining their heuristics with an aim to increase their simplicity and adaptability (Bingham & Eisenhardt, 2011).

The *simplicity* of heuristics ensures their efficient encoding in firms' memories for better recollection and updating (Bingham & Eisenhardt, 2011). In addition, simplified heuristics

provide firms space to modify their heuristics according to changes in the business environment and therefore increase their adaptability. An *adaptable* set of heuristics enables firms to be less fixated and move beyond applying previous solutions to future problems (less specific to a particular context). Such modifications may guide management to explore possible approaches of implementing changes in the firm's resource base (e.g., varying IT systems to create new marketing capabilities) (Simon, 1955; Todd & Miller, 1999).

Simplification cycling can be explained by extending the VCR example from above. As Shiraishi's team went through an iterative trial-and-error process, they developed a list of 12 criteria specific to a particular context that needed to be fulfilled. Shiraishi then purposefully simplified the heuristic reasoning to what he described as "a device [that] must be intelligible to the people who make it, the people who buy it, and the people who have to fix it" (Nayak & Ketteringham, 1986: 15). Such simplification cycling resulted in simpler, more memorable heuristics and is thus likely adaptable to the changing business environment

In summary, retention of heuristic reasoning occurs after the process of variation and selection has been completed and a new opportunity is successfully created (see the retention stage in Figure 1). It is important to re-emphasize that the retention stage does not involve the development or utilization of new heuristics; instead, firms refine their existing heuristics developed throughout the variation and selection stages of proactive DC deployment to ensure their simplicity and adaptability.

To review, we have thus far addressed our first question of *how* heuristic reasoning facilitates proactive DC deployment. We have delineated the role of heuristic reasoning in enabling the creation of an opportunity through variation, selection, and retention stages of proactive DC deployment. Comprehensive theorizing on proactive DC deployment, however,

requires an explanation of *why* the use of heuristic reasoning is effective in such a process. In the next section, we therefore delve deeper into our second question and elucidate the underlying mechanism of the why question we depict in Figure 1.

Why Ecologically Rational Heuristic Reasoning Is Effective for Proactive DC Deployment

The effectiveness of heuristic reasoning is determined by the degree of confidence in its expected outcome. As we alluded to above, a key concern about heuristic reasoning is whether it leads to an inferior decision outcome compared to deductive reasoning. Therefore, in this section, we complete our theorizing by explaining why heuristic reasoning is effective in uncertain environments: (a) by overcoming perceived underalignment and overalignment and (b) by refining confidence (i.e., belief in the expected outcome) during the process of proactive DC deployment.

We begin by drawing on the concept of the bias-variance tradeoff to explicate why the simplicity and adaptability of heuristic reasoning lead to a balance between bias and variance, two key factors that affect confidence in a decision. Finding a balance allows firms to overcome underalignment (i.e., high bias and low variance) and overalignment (i.e., low bias and high variance) during the variation, selection, and retention stages of proactive DC deployment (see the summary of our arguments in the first row of "WHY" in Figure 1 and its schematic illustration in Figure 2). We then discuss why the simplicity and adaptability of heuristic reasoning enable learning through the iterative process of proactive DC deployment, which in turn allows firms to continuously obtain and process new information, reprocess the past information, and update their heuristics to refine the confidence in their heuristic reasoning (see the summary of our arguments in the second row of "WHY" in Figure 1 and its schematic illustration in Figure 3).

Overcoming underalignment and overalignment. As we suggested earlier, using heuristic reasoning in proactive DC deployment enables the firm to focus on a few pieces of information in an adaptive way. In essence, the simple and adaptive characteristics of heuristic reasoning can mitigate the bias and variance in uncertain environments, by overcoming both under and overalignment. In an uncertain environment, decision making is prone to under and overalignment, which are detrimental to confidence in decision, and therefore need to be carefully managed (Bishop, 2006). We note that in uncertain environments, decision makers are often unaware of the extent to which they rely on past information as well as the relevance of that information. Thus, under and overalignment represent their perception of the information and context. Figure 2 serves as a foundation for us to (1) demonstrate, through the concept of the bias-variance tradeoff, the occurrence of underalignment and overalignment and (2) demonstrate how the logic of Figure 2 complements Figure 1 (i.e., the first row of "WHY" in Figure 1). Below we explain the key terms introduced in this section (e.g., decision rule, confidence, bias, and variance) and unpack their relationships as illustrated in Figure 2.

Insert Figure 2 about here

To examine the relationship between simplicity, which varies across reasoning approaches, and confidence, we need to step back and define a decision rule as a higher-level construct that encompasses all reasoning approaches. It ranges from a highly complex decision rule—toward the left-hand side of the x-axis in Figure 2—to a highly simple decision rule—toward the right-hand side of x-axis in Figure 2. The concept of a decision rule allows us to explain why heuristic reasoning is effective in uncertain environments compared to deductive reasoning. The simplicity of a decision rule is a function of the extent of information and analytical effort required to assess an idea (Holmström & Myerson, 1983), ranging from low to

high (see the x-axis of Figure 2). A simple decision rule requires less information and analytical effort, and thus is more adaptable (i.e., heuristic reasoning). In contrast, a more complex (lower degree of simplicity) decision rule requires more information and analytical effort, and thus is more specific to a particular context and less adaptable (i.e., deductive reasoning).

We define confidence as the expectation that decision makers place in the outcome of a decision (King, Keohane, & Verba, 1994; Munn et al., 2014). Confidence is determined by two error components: bias and variance.[5] We note that confidence, bias, and variance are indicative of decision makers' perceptions because in uncertain environments decision makers do not know the outcome of a decision *ex ante*. The "truth" in the context of proactive DC deployment is socially constructed by decision makers intersubjective experiences and their iterative enactment process (Alvarez et al., 2013; Angen, 2000; Kvale, 1994). Therefore, decision makers can merely estimate the truth and error based on their perception of available information, which in turn helps them to forge a path forward in such an environment (Alvarez & Porac, 2020). Accordingly, confidence in a decision rule can be increased by minimizing bias and variance. In Figure 2, the vertical axis represents error in a decision rule, which reflects the extent to which confidence in a decision rule is impaired by bias or variance, while the total error curve represents the sum of bias and variance. To avoid the issue of underalignment and overalignment, the focus should be on reducing *total error* (i.e., increasing confidence), which can only be achieved when firms balance between bias and variance and not simply focus on one while ignoring the other (Artinger et al., 2015).

[5] Random noise is discussed in the literature as a third error component. However, because random noise is uncontrollable, we exclude it from our discussion here.

The first component, *bias,* refers to "the difference between the mean across samples and the true underlying mean" (Artinger et al., 2015: 36). In other words, it is the difference between the estimation derived through a decision rule and the real value of what we attempt to estimate (Fortmann-Roe, 2012). Thus, a high level of bias occurs when a decision rule is oversimplified and unable to capture the real value (Briscoe & Feldman, 2011). Because the information required to estimate the real value is often unknown *ex ante*, especially in an uncertain environment associated with proactive DC deployment, it is challenging for firms to develop an understanding about the confidence in their assessment of a new idea *ex ante.* Instead, this understanding gradually develops and becomes more complete *ex post* after the opportunity has reached its commercial viability.

The second component, *variance,* stems from the variability in the estimation that a decision rule produces when applying it to new contexts (Gigerenzer & Gaissmaier, 2011). High levels of variance occur when a decision rule aligns with a specific context (i.e., its original context) but does not align with other contexts. Therefore, a decision rule with high variance performs poorly in an uncertain environment because the new context often differs greatly from the original context. As a result, an attempt to align such a decision rule to a different context can impair the confidence in an assessment of a new idea.

While a simple decision rule benefits from less information and analytical effort, its confidence can be compromised by higher bias, as it directs firms to rely on general knowledge or a few generic criteria that are not context-specific. The result of this process is underalignment and low confidence. Underalignment, as shown in Figure 2, occurs when decision makers fail to capture and use relevant information from past knowledge to understand (or learn about) a new

idea. Given the lack of information in uncertain environments, proactive DC deployment is vulnerable to underalignment in the assessment of new ideas (Hargadon & Douglas, 2001).

Returning to our VCR example, while the JVC team initially was concerned about two simple criteria, "Could the device be used at home? Can average consumers afford it?", their lack of information (due to uncertainty) on what might become the industry standard and/or what consumers might prefer resulted in low confidence in the new idea and was evident in the new product. The new product, despite being small and affordable, failed because it did not meet what became the industry standard. More specifically, Ampex's quadruplex videotape was widely adopted by customers and had already become the industry standard. JVC's smaller and cheaper VCR could not compete since its two-head VCR was incompatible with the videotape player most customers had (Nayak & Ketteringham, 1986: 9-10).

In contrast, drawing excessively on past information is problematic because such information may be less relevant to the current context, particularly in uncertain environments. In this case, relying too heavily on past information may be distracting to a new assessment and can result in overalignment (Gigerenzer, 2002, 2016; see Woodside, 2016). Overalignment, as shown in Figure 2, occurs when a decision rule draws on more information than required and demands more complex analytical processes. While such a complex decision rule is more robust to bias, it can result in a higher level of variance leading to an increase in total error and a decline in confidence.

In addition, a decision rule that leads to overalignment lacks general and transferable information and know-how (i.e., having high context specificity and low adaptability) and thus performs poorly when a decision-making context differs from the decision rule's original context. This issue is particularly pronounced in uncertain environments where information is

sparse, and the situation is less likely to repeat itself (Gigerenzer & Gaissmaier, 2011; Mousavi & Gigerenzer, 2014). For example, 3M ignored the new idea of Post-it Notes for many years because many of the company's observers of new product ideas overly aligned their understanding of weak adhesive to existing glues when trying to make sense of it and failed to identify its differences and market potential (see Arikan et al., 2020; Nayak & Ketteringham, 1986).

Therefore, when assessing new ideas, firms need to alleviate overalignment in order to enhance the adaptability of insights drawn from past information and know-how (Bishop, 2006) while at the same time avoiding falling prey to underalignment. To do so, firms apply heuristic reasoning that makes use of few pieces of past, seemingly relevant information, while simultaneously maintaining a sufficient degree of adaptability for future situations that are likely to be different.

The perspective of ecologically rational heuristic reasoning suggests that heuristic reasoning overcomes underalignment and overalignment by focusing decision makers' attention on selected information and reducing the need for complicated analytical processes, while still using (the seemingly most relevant) past information and existing know-how—that is, "less is more" (Mousavi & Gigerenzer, 2014, p. 1677). Accordingly, heuristic reasoning functions well under the constraints of limited information and prior knowledge (Gigerenzer & Selten, 2001) because it is not concerned with consistency and coherence of past information and existing know-how. Instead, it focuses on adaptability by aligning heuristics with the available information and structure of the current environment and the simplicity that removes the need for a complicated analytical process. Hence, a heuristic reasoning approach is particularly effective for assessing new opportunities in an uncertain environment in which collecting or analyzing

comprehensive information is challenging (Alvarez & Barney, 2007). Attempts to do the latter may result in analysis paralysis (Huang, 2018) and/or overalignment of the current situation to past knowledge and experience (Gigerenzer & Selten, 2001).

In essence, while the initial use of heuristic reasoning may result in underalignment in uncertain environments, its simplicity assists firms in adapting to the new context and achieving "good enough" confidence (i.e., the best a firm can achieve given the limited information) during the variation and selection stages of opportunity creation. This level of confidence allows firms to develop a satisfactory understanding about a new idea and the ability to make decisions and move forward with acting and reacting. As firms go through this iterative process, they accumulate and process new information and reprocess past information, which further refine their heuristic reasoning and add to the confidence. While this process may lead to overalignment over time, this tendency is counterbalanced during the retention stage in which specific heuristics undergo simplification cycling to ensure their simplicity for future use.

We further argue that while we discuss the concepts of error and confidence in decision making, "optimal" confidence is not a goal, as it has no validity in an uncertain environment due to a general lack of information. Instead, we emphasize the importance of "good enough" confidence because without some initial understanding of an idea, its potential benefits, and the development process, a firm cannot move forward with an idea. Drawing on our VCR example, the team initially focused on two simple criteria (i.e., price and ease of use), making this heuristic prone to underalignment. Despite being initially low in confidence, few criteria used in their heuristic reasoning offered enough understanding to move forward and further develop the VCR.

In the next section, we explain why the simplicity and adaptability of heuristic reasoning allow the refinement of confidence as the result of learning from the iterative process of action

and reaction during the variation and selection stages of proactive DC deployment. In addition, we explain why such characteristics enable a refinement of heuristics during the retention stage.

Refining confidence. Lack of information and limited understanding are more pronounced in the early stages of proactive DC deployment. Despite the usefulness of heuristic reasoning in this initial stage, the confidence in its outcome is often problematic (Bingham, Howell, & Ott, 2019). In other words, in the early stages of proactive DC deployment, the novelty of an idea may result in misunderstanding it or preventing the selection of the most relevant criteria or the most relevant heuristic (i.e., Type I error). While Figure 2 illustrates the relationship between the degree of simplicity of a decision rule and its error in relation to bias and variance, it does not capture the dynamics of how total error of a decision rule may change through the process of iterative learning and simplification cycling.

To illustrate these dynamics, Figure 3 offers a schematic representation of how simplicity and adaptability of heuristic reasoning enable learning from the iterative process and simplification cycling that in turn result in changes in the level of bias, variance, total error, and confidence. More specifically, Figure 3a illustrates the refinement of confidence through learning from the iterative process during the variation and section stages of proactive DC deployment. This also reflects our discussion of the "WHY" question (the second row) in the variation and selection stages in Figure 1. Figure 3b then demonstrates the refinement of confidence through the simplification cycling during the retention stage and represents our discussion of the "WHY" question (the second row) in the retention stage in Figure 1.

Insert Figure 3 about here

The baseline in Figure 3a shows that given the lack of information in uncertain environments, an initial decision rule tends to be overly simple (located towards the right side –

high degree of simplicity). It involves high bias and low variance (i.e., underalignment), thereby resulting in low, yet "good enough" confidence. However, as firms go through iterative learning, they accumulate and process new information, while simultaneously reprocessing the previously obtained information to develop a better understanding of the current context. This process alleviates underalignment (the solid line moves toward the left along the horizontal axis in Figure 3a). This is because learning occurring during the iterative feedback loop within and between the variation and selection stages (see Figure 1) allows the firm to draw on more information, new ideas, and perspectives (i.e., increased variance), thereby refining the decision rule to become more complex (lower degree of simplicity) but more confident in relation to the specific context (i.e., decreased bias) for which it has been developed (see the solid vertical line in Figure 3a).

In other words, the iterative nature of proactive DC deployment provides firms with real-time market feedback regarding the new idea and allows them to incorporate this learning to refine the heuristic reasoning used in the variation and selection stages (Argote, 1999; Sitkin, 1992). As the learning progresses and new information becomes available, firms gradually incorporate and refine this new knowledge by abandoning obsolete criteria, adding new criteria proven useful in the current context, and/or modifying their decision rules generated in earlier stages. These actions enable firms to update and refine their decision rules based on new information—exploiting the benefit of variance—to align the current context in which an assessment of a new idea is taking place.

More specifically, these actions lead to a decrease in bias and an increase in variance of a decision rule as the inclusion of context-specific information gained through feedback improves an understanding of a new idea and, thus, reduces error and increases the confidence in decision rules (Bingham et al., 2019). This process is illustrated by the move from the vertical baseline to

the solid vertical line in Figure 3a. Returning to our VCR example, the adaptive nature of heuristic reasoning enabled Shiraishi's team to learn during the variation and selection stages. Iterative learning mitigates underalignment (reducing error from bias) as firms include more criteria in their heuristic reasoning to reach the balance between bias and variance, thereby minimizing total error and improving their confidence.

This is in line with entrepreneurship research, which suggests that the process of opportunity creation is iterative in nature. More specifically, as entrepreneurs act upon their new idea, they observe the market reaction and engage in a series of feedback loops (Amabile, 1983) throughout the variation and selection stages. The opportunity creation perspective further suggests that the opportunity creation process is socially constructed and involves interaction with individuals both inside (e.g., engineers, scientists, marketing managers, and finance managers [Ross & Fisch, 2018]) and outside the firm (e.g., customers and suppliers [Alvarez et al., 2013; Foss, Lyngsie, & Zahra, 2013]).

As such, firms often incorporate their learning gained from feedback to revisit and refine their ideas (Alvarez et al., 2013) until a new opportunity is successfully created or failure occurs. This process of learning through feedback has been discussed in the experiential learning and strategy-by-doing literature as the elaboration process (e.g., Anand & Khanna, 2000; Chen, Wang, Cui, & Li, 2021; Furr & Eisenhardt, 2021; Helfat & Peteraf, 2003), suggesting that decision makers often start by relying on a few simple decision rules before gradually incorporating knowledge gained through trial and error and social interaction to improve the context-specificity and, hence, confidence in their decision rules.

Next, Figure 3b demonstrates how the simplification cycling during the retention stage leads to an increase in simplicity of a decision rule, resulting in an increase in bias and a decrease

in variance, and, hence, a decline in confidence when applying a decision rule to a new context. We explained in the retention section that as firms proceed to seize and exploit an opportunity, they are likely to accumulate a set of reliable and step-by-step decision rules (Eisenhardt & Tabrizi, 1995; Kale & Singh, 2007; Szulanski & Jensen, 2006) formed during the variation and selection stages of proactive DC deployment. While such decision rules are valuable in the specific context in which they are developed, their lack of simplicity reduces their adaptability to different contexts as well as their retrievability from memory. This may also result in confusion and even conflicting guidance (Bingham & Eisenhardt, 2011). Therefore, it is important for firms to engage in simplification cycling to maintain the simplicity and adaptability of their heuristic reasoning (Bingham & Eisenhardt, 2011).

As firms engage in simplification cycling, they track additions and deletions of their decision rules to produce a limited set of simple yet adaptive decision rules. In turn, these rules can easily be remembered and retrieved (see the retention stage in Figure 1) to facilitate sensemaking, development, and selection of variations of the newly created opportunity as the business environment changes (Bingham & Eisenhardt, 2011). In doing so, firms may combine or replace certain decision rules with simpler ones. This process results in increasing bias and reducing variance of a decision rule (see the move of the vertical line from the solid line on the left toward the dashed line on the right along the horizontal axis in Figure 3b). While the confidence in such heuristic rules remains intact for the context in which they were developed, such simplification cycling will lead to compromised confidence when these decision rules are applied in a new context.

However, given that in the uncertain environments associated with proactive DC deployment the future context likely differs from what the firm has experienced and incorporated

into its decision rules, the confidence in a decision rule decreases when applied to the new context. Therefore, these decision rules may only be useful for initiating sensemaking and taking early actions on future opportunities. These simplified heuristics will likely undergo an underalignment issue at first. However, their confidence will improve as the result of the iterative process of action and reaction in the future contexts (see the feedback loop between retention and variation stage in Figure 1).

DISCUSSION

Unsettled theoretical assumptions and a lack of understanding of the underlying mechanisms of DCs have drawn ongoing criticism (see Barreto, 2010; Peteraf et al., 2013; Schilke et al., 2018), leaving their value to strategic management research in question. For example, while the existing DC literature has related DC deployment to opportunities, questions of how opportunities arise and their underlying processes have been widely overlooked (Schilke et al., 2018). We argued that DC scholarship can clarify these conceptual limitations by providing more specific and in-depth theorizing about DCs' underlying assumptions.

Perhaps the most important consideration is a clear distinction between reactive and proactive DC deployment that further elucidates the ongoing debate regarding uncertainty—an important boundary condition of the original conceptualization of the DC view (Teece, 2007; Teece et al., 1997). This also enables a thorough examination of how the conceptualization of DCs might differ in these two settings. By incorporating the concept of ecologically rational heuristic reasoning and the opportunity creation perspective, we responded to Schilke et al.'s (2018) suggestion to extend the DC literature by infusing the DC view with psychological and entrepreneurship theory. In particular, we explicated the underlying process of proactive DC

deployment, which is associated with uncertainty: How heuristic reasoning facilitates variation, selection, and retention in opportunity creation during proactive DC deployment.

Our explicit distinction between reactive and proactive DC deployment and our focus on the latter also allowed us to respond to the ongoing debate in the DC literature about the usefulness and application of heuristic reasoning (Di Stefano, Peteraf, & Verona, 2014; Eisenhardt & Martin, 2000; Helfat & Peteraf, 2015; Peteraf et al., 2013; Schilke et al., 2018; Teece & Leih, 2016; Teece, 2007). While the application of heuristic reasoning in DC deployment has been acknowledged (Eisenhardt & Martin, 2000), scholars have yet to understand how this type of reasoning can be applied to the conceptualization of DCs (Teece et al., 1997) and what the outcome implications might be (Di Stefano et al., 2014; Helfat & Peteraf, 2015; Peteraf et al., 2013).

Much previous strategic management research has drawn on the "heuristic and bias" perspective (Tversky & Kahneman, 1974), which emphasizes the inferior outcome of heuristic reasoning, thus neglecting the "ecologically rational heuristic reasoning" perspective (Gigerenzer & Selten, 2002). This has led to a one-sided view of heuristic reasoning and its use in strategic management research. Our theorizing clarified *how* and *why* heuristic reasoning is useful and enhances adaptive decision making, which is necessary for proactive DC deployment and the context of uncertainty. In addition, our discussion shed light on the circumstances under which heuristic reasoning would be beneficial for firms. We, therefore, extend the theoretical assumptions of earlier work that has begun to integrate this ecologically rational heuristic reasoning perspective into management research (Artinger et al., 2015; Bingham & Eisenhardt, 2011; Luan, Reb, & Gigerenzer, 2019; Maitland & Sammartino, 2015; Mousavi & Gigerenzer,

2014). We also highlighted the usefulness of ecologically rational heuristic reasoning by discussing its underlying process and enabling mechanisms.

Our theorizing also contributes to both the DC literature and a broader literature on the resource-based view. The key propositions of the resource-based view of the firm are that among firms' heterogeneous resources and capabilities, not all resources and capabilities are of equal value. That is, firms' sustainable competitive advantage can only be achieved when firms' resources and capabilities are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991; Barney et al., 2001). Similarly, the DC literature focuses on how DC deployment may result in sustainable competitive advantage (see Barreto, 2010; Peteraf et al., 2013; Schilke et al., 2018). Our distinction between reactive and proactive DC deployment and our in-depth explanation of the underlying process of proactive DC deployment suggest that proactive DC deployment more likely contributes to the creation of a new resource base (and, hence, new opportunity) with VRIN characteristics. The lack of past information and existing know-how and embedded uncertainty of proactive DC deployment makes it unlikely that competitors will come up with a similar idea and develop it into a similar new opportunity (Alvarez & Barney, 2007).

Instead, the underlying process of proactive DC deployment is idiosyncratic and path-dependent as an outcome of an iterative learning process and accumulated experience. This process often leads to a new or unexpected path that could not be created otherwise (Vergne & Durand, 2010, 2011). Hence, such a process can ensure that an initial idea of a potential new opportunity differs from the ultimate outcome, and its deployment process can only be fully understood retrospectively (Alvarez & Barney, 2007), creating a causal ambiguity advantage for the firm (Argote, 1999).

While our integration of the opportunity creation perspective (Alvarez & Barney, 2007) from entrepreneurship research enabled us to further advance the DC literature (Schilke et al., 2018), we believe that our theorizing on proactive DC deployment also adds to ongoing debates in entrepreneurship research in two ways (e.g., Alvarez & Barney, 2007; Alvarez et al., 2013; Foss & Klein, 2017; Foss, Klein, & Bjørnskov, 2019). First, despite the use of heuristic reasoning in the opportunity creation literature (e.g., Alvarez & Barney, 2007), its role and enabling mechanisms have not yet been fully explained. Our theorizing on how and why heuristic reasoning facilitates successful creation of an opportunity bridges the gaps in this literature and offers a better understanding of how firms create "something out of nothing" (Baker & Nelson, 2005: 330).

Second, given that the context of entrepreneurship research is mostly associated with uncertainty where paths and outcomes are not clear (Alvarez & Barney, 2007; Alvarez & Parker, 2009), our conceptualization of heuristic reasoning in proactive DC deployment further extends the understanding of entrepreneurial decision making, particularly the underlying mechanism and the value of ecologically rational heuristic reasoning under uncertainty. More broadly, our theorizing at the individual (i.e., decision maker) level of DC deployment also contributes to the behavioral strategy and microfoundations literature (e.g., Powell, Lovallo, & Fox, 2011; Vuori & Vuori, 2014) that have gained increased traction among strategic management scholars in the past decade (e.g., Foss et al., 2019; Teece et al., 2016; Teece, 2016).

Our discussion about the underlying process of heuristic reasoning in opportunity creation also explains the collective creation and development of heuristic reasoning at the firm level. We argue that while heuristic reasoning is used by managers to facilitate decision making during the proactive DC deployment process, the interaction between individuals involved in this

process further reshapes and refines the heuristics within a firm. This is in line with Bingham et al. (2019) argument that suggests that while an initial idea may have been proposed by an individual or a group of individuals, it is often top managers who mandate the development process, facilitate the interaction between departments, and determine which variant of an idea should be selected for future implementation.

Future Research Directions

Future research can expand our theoretical framework by investigating the usefulness of ecologically rational heuristic reasoning in the process of reactive DC deployment (i.e., opportunity discovery). The opportunity discovery perspective assumes that opportunities are the outcome of exogenous shocks. Thus, firms (a) become aware of the opportunity by systematically searching the environment and (b) at the time of decision making can collect sufficient relevant information to engage in deductive reasoning. To remain competitive, firms need to consider both the type (local and distant) and speed of their search for an opportunity, while simultaneously responding to the opportunity truley and ahead of their competitors (Alvarez & Barney, 2007; Delios & Henisz, 2003; Penrose, 1959; Porter, 1985; see also D'Aveni, Dagnino, & Smith, 2010). This poses a competing pressure on firms and raises a critical question of whether firms can collect sufficiently trustworthy information for deductive reasoning and respond to the newly discovered opportunity in a timely manner. This competing demand for trustworthy and speed in reactive DC deployment is particularly challenging, causing deductive reasoning (Alvarez & Barney, 2007; Teece, 2007) to be time and effort consuming (i.e., in collecting comprehensive information) (Kahneman & Frederick, 2002).

Future research in DCs and entrepreneurship can delve deeper into the competing requirements that underpin opportunity discovery and investigate how uncertainty plays a role in

such contexts. In addition, our work informs future research on the application of ecologically rational heuristic reasoning in the opportunity discovery context. Specifically, we suggest that ecologically rational heuristic reasoning enables sufficiently trustworthy estimation of future outcomes as well as fast responses to changes and opportunities in the environment (Gigerenzer, 1996; Kahneman & Tversky, 1996).

Our proposed theoretical framework also provides opportunities for empirical research. For example, prior studies in managerial cognition (e.g. Barr, Stimpert, & Huff, 1992) have suggested that cognitive processes can be deduced from analyses of language patterns (Duriau, Reger, & Pfarrer, 2007). Hence, we suggest that longitudinal content analyses on firms' data (e.g., emails, meeting minutes of a specific project, conference calls, and annual reports) could provide meaningful insights and a basis for empirically testing the arguments put forward in this paper. Complementary empirical research could also draw on an in-depth, longitudinal case analysis to investigate specific strategic changes (e.g., entering a new market or developing a new business model) and seek to detect management uses of heuristic reasoning in such situations (e.g., Bingham & Eisenhardt, 2011; Maitland & Sammartino, 2015).

Our proposed theoritical framework draws on a distinction between proactive and reactive DC deployment, with a focus on the former. However, the question of whether or how proactive and reactive DC deployment are intertwined remains. Our theorizing encompassed the point from which an idea about a potential new opportunity is created to the point from which the idea is fully developed into a newly created opportunity. In principle, one could argue that reactive DC deployment occurs when the new opportunity has been introduced to the market, and a firm learns from customers' and competitors' responses to refine its product. Future research could investigate this suggested interrelationship more deeply.

Given our focus on proactive DC deployment, our paper described a situation wherein the decision context is uncertain and heuristic reasoning is used. Nevertheless, the question of how decision makers can know *ex ante* whether the decision context is risky or uncertain remains open (Rindova & Courtney, 2020). For example, Miller (2007: 58) suggested that "neither risk as statistical probability nor uncertainty is devoid of personal judgment. Both involve subjective classification of states, albeit with different degrees of difficulty—ranging from straightforward to impossible." In contrast, Alvarez and Barney (2005: 779) argued "whether a decision to invest in a market opportunity is risky or uncertain depends on the objective properties of that investment, not on the perceptions of decision makers." The lack of clarity in the literature has further highlighted the importance of this question and the need for future research (Rindova & Courtney, 2020).

Misjudgement an uncertain environment as risky or vice versa, however, may result in an inferior decision. This was illustrated in our Post-It Notes example, where some 3M engineers and managers overfit their understanding of the weak glue with the existing market for glue. The development team misjudged the situation as one of risk (rather than uncertainty) and thus overlooked the usefulness of weak glue. Our argument here is in line with that of Alvarez and Barney (2005), which suggested that decision makers may think they can estimate the probability distribution of outcomes associated with a decision even when the necessary data are unavailable.

However, decision makers often underestimate the nature of an uncertain environment. Therefore, we encourage future research to bridge the gap between these two lines of argumentation by investigating (a) the factors impacting individual perceptions of risky or uncertain environments (including overconfidence), (b) how and when individual perception of a

decision context reflects the true characteristics of the decision context, and (c) how the use and effectiveness of different reasoning approaches depend on the subjectivity or objectivity of the decision context.

Conclusion

We advanced the theoretical assumptions of the DC view and the broader resource-based view literature by theorizing about the heuristic reasoning process in proactive DC deployment. Specifically, our explicit distinction between reactive and proactive DC deployment highlights the extent to which decisions are characterized by risk or uncertainty. In addition, our incorporation of ecologically rational heuristics extends our understanding about the cognitive foundations of research in entrepreneurship and behavioral strategy. In doing so, we offer a better understanding of *how* and *why* heuristic reasoning effectively facilitates opportunity creation and proactive DC deployment. Finally, our work has implications for critical questions in both the DC and resource-based view literatures: How are heterogeneous resources and capabilities created, and how do they contribute to firms' sustainable competitive advantage?

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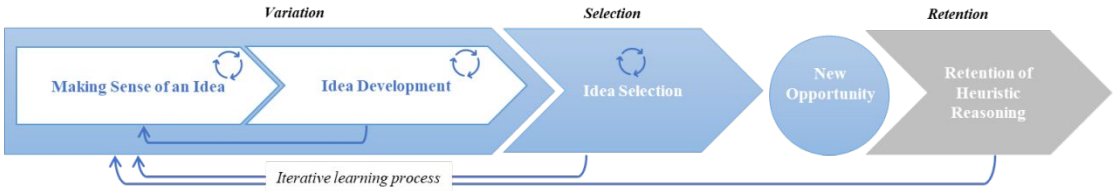
FIGURE 1

Heuristic Reasoning in Proactive Dynamic Capability Deployment



		How is a new idea made sense of?	What are the possible paths for developing a new idea?	Which variant of a new idea should be selected for further development?	Role of Simplification Cycling in HOW and WHY: How can the firm retain useful heuristics?
HOW *(simplicity and adaptability of)* **heuristic reasoning facilitates proactive DC deployment**	*Simplicity*	Few pieces of past information and less analytical effort to reasonably make sense of a new idea	Few pieces of know-how and less analytical effort to sufficiently understand how to act	Few selection criteria and less analytical effort to pursue a variant of a new idea	Pruning heuristics through simplification cycling to ensures that the simplicity and adaptability of heuristic reasoning are maintained
	Adaptability	Identify those pieces of past information that are most relevant for making sense of a new idea	Identify those pieces of existing know-how that are most relevant for developing a new idea	Identify from the existing criteria that best suit the new market for pursuing a variant of a new idea	
WHY *(simplicity and adaptability of)* **heuristic reasoning is effective in proactive DC deployment**	*Overcoming Underalignment/Overalignment (see Figure 2*)*	Enable bias-variance trade-off to sufficiently make sense of a new idea	Enable bias-variance trade-off to sufficiently identify development path of a new idea	Enable bias-variance trade-off to select sufficient market criteria to pursue a variant of a new idea	Simplified and more adaptable heuristics are both more memorable and useful for future use (see *Figure 3b**)
	Refining confidence (see Figure 3a)*	Enable learning from the iterative process to refine heuristics used to make sense of a new idea	Enable learning from the iterative process to refine heuristics used to develop a new idea	Enable learning from the iterative process to refine criteria and heuristics used in idea selection	

*Figures 2, 3a, and 3b explicitly illustrate the underlying processes at these stages.

FIGURE 2

Why Heuristic Reasoning is Effective in Proactive Dynamic Capability Deployment: Overcoming Underalignment and Overalignment[a]

[a] The curves are general representations. In reality, their shapes may be less symmetric.

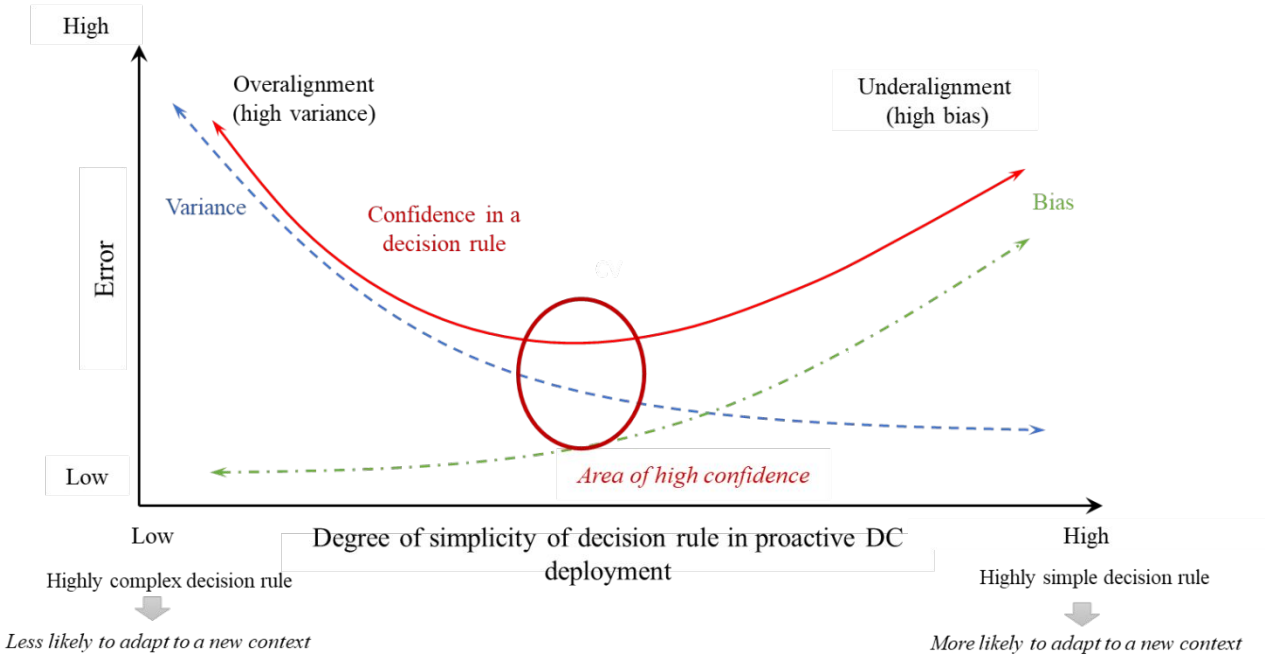
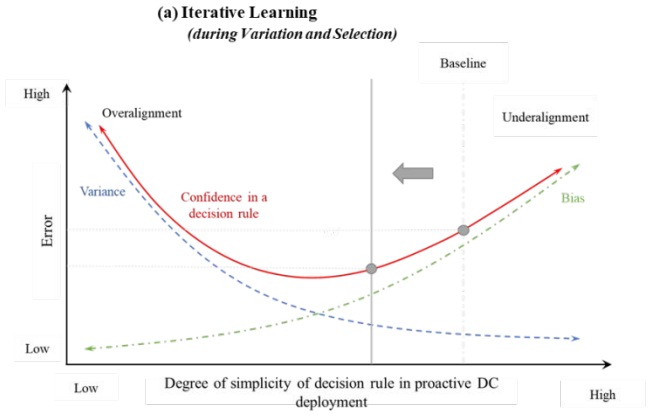


FIGURE 3

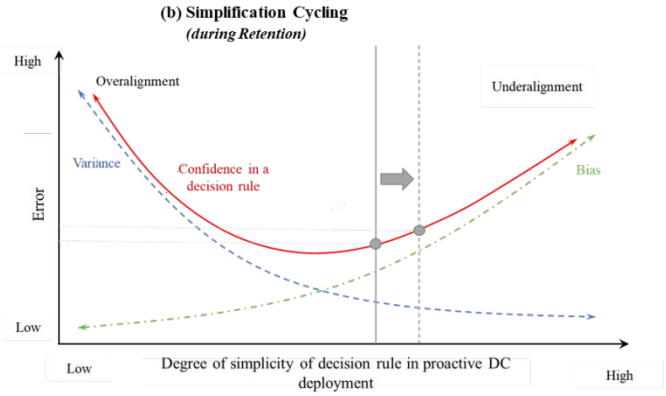
Why Heuristic Reasoning is Effective in Proactive Dynamic Capability Deployment: Refining Confidence[b]

[b] The curves are general representations. In reality, their shapes may be less symmetric.



As firms go through the *iterative learning* process (move from right to left):

- A decision rule is refined to aligns with the current context and becomes more complex
- The extent of information and analytical effort increases
- Confidence increases for the current context
- The adaptability to new contexts decreases



As firms go through the *simplification cycling* (move from left to right):

- A decision rule is simplified
- The extent of information and analytical effort decreases
- Trustworthiness:
  - Decreases when applied in new contexts
  - Remains intact when applied in the current context
- The adaptability to new contexts increases

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